§1. Measurement Error of Radiation Monitoring by Means of an Electronic Dosimeter

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Integrating dosimeters are applied to continuous environmental radiation measurement. It is general to use the thermo-luminescence dosimeter or the radiophoto-luminescence dosimeter as the integrating dosimeter. On the other hand, in recent years electronic integrating dosimeter begins to be utilized for measuring individual dose and the ambient dose in radiation working area. In this study, the measurement error and the sensitivity difference between dosimeters were evaluated. Using these data, the reduction of the measurement error was discussed.

The electronic integrating dosimeter used in this study is able to record the time trend data of the dose. The minimum radiation dose unit is 1 μSv. Whenever 1 μSv is increased, the integrated dose is recorded the achieved time to secure memory of the dosimeter. When 1 μSv is divided by the time needed for the increase, the dose rate is provided. The smallest unit of the record time interval is two seconds. Data saved in the memory can be forwarded to a personal computer by the infrared communication.

The measurements were done in three kinds of dose rate environment, such as 55 nSv/h, 120 nSv/h and 1.2 μSv/h. Thirty two dosimeters were used in each measurement. The dosimeters were exposed more than 40 μSv as integrated dose. The dose rate that the integrated dose reached 40 μSv is different between the dosimeters. The dispersions were expressed in 1σ. When the dose rate was 55 nSv/h, 123 nSv/h, 1.2 μSv/h, the dispersion was 2 nSv/h, 3 nSv/h, 20 nSv/h, respectively. As a result, the sensitivity difference between the dosimeters was less than 4 %. The systematic error was not recognized. In addition, 40 data were obtained for one dosimeter since every 1 μSv were recorded in the process of accumulating 40 μSv. The standard deviation 1σ was 5 nSv/h, 10 nSv/h, 0.11 μSv/h, when the dose rate was 55 nSv/h, 123 nSv/h, 1.2 μSv/h, respectively. Consequently, the measurement error of the dosimeters was less than 10 %.

Figure 1 shows the example of the change in dose rate through integrating 40 μSv. The dose rate is 55 nSv/h. The dose rate at 40 μSv was normalized as 1 for each dosimeter. The measurement error is less than 20 %, even when the integrated dose is 1 μSv. Furthermore, when the integrated dose is 3 μSv, the measurement error is less than 10 %. When the integrated dose is 15 μSv, the measurement error is less than 5 %. When the sensitivity difference between dosimeters of 4 % is taken into account, the best measurement precision is provided at more than 15 μSv of integrated dose. In other words, in the environment of 50 nSv/h, highly precise measurement can be done on environmental monitoring by means of integrating dose for 12.5 days.

Figure 2 shows the response irradiated on 1.05 μSv/h for two hours. The dose rate was measured correctly, the time delay of detection was 0.75 hour. The background dose rate was 0.12 μSv/h. The net dose 2.14 μSv was evaluated when the background dose was deducted.

The sensitivity difference between dosimeters was very small, and the systematic sensitivity difference was not recognized. Therefore, it was made clear that it was not necessary to manage the sensitivity of dosimeter individually, and the highly precise radiation monitoring was possible. The time when the dose rate would be changed can be grasped by using time trend data of the electronic integrating dosimeter. An accurate net dose can be evaluated with one dosimeter, because the background dose is recorded when the dosimeter is not irradiated by radiation sources. As a result, the electronic integrating dosimeter can be applied to environmental radiation monitoring.

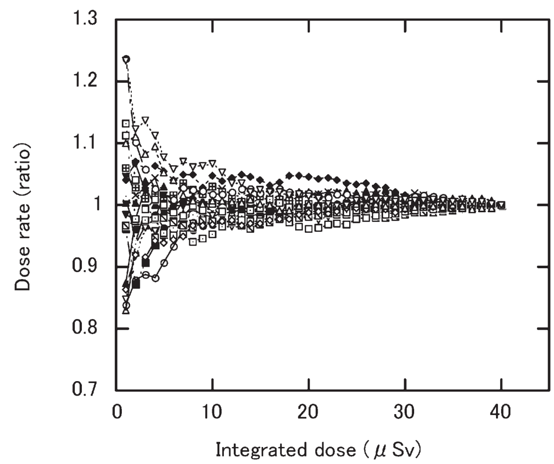

Fig. 1 Change in dose rate through integrating 40 μSv. The dose rate at 40 μSv was normalized as 1 for each dosimeter.

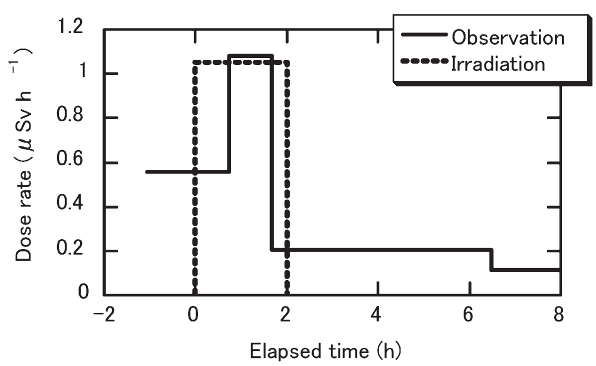

Fig. 2 Time variation of dose rate. The dosimeter was irradiated at 1.05 μSv/h for 2 hours.